REMARKS

Please reconsider the present application in view of the above amendments and the following remarks. Applicant thanks the Examiner for carefully considering this application.

Disposition of Claims

Claims 1-13 were pending in the present application. Claim 2 has been cancelled by this reply. Therefore, claims 1 and 3-13 are pending after the amendments. Claim 1 is independent. The remaining claims depend, directly or indirectly, from claim 1.

Claim Amendments

Independent claim 1 has been amended to clarify the invention recited. Specifically, claim 1 has been amended to include a limitation in the cancelled claim 2. No new matter is introduced by this amendment.

In addition, claims 3, 5, 7-9, and 11 have been amended to correct typographical errors or antecedent problems. No new matter has been introduced by these amendments.

Claim Objections

Claim 11 was objected to due to a typographic error. This error has been corrected. Accordingly, withdrawal of this objection is respectfully requested.

Rejection(s) under 35 U.S.C § 112

Claims 8 and 9 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention.

The Applicant thanks the Examiner for carefully reviewing the claims. This rejection arises from typographical errors. These errors have been corrected. Specifically, claims 8 and 9 have been amended to depend from claims 4 and 5, respectively. Accordingly, withdrawal of this rejection is respectfully requested.

Rejection(s) under 35 U.S.C § 102

(A) Claims 1-3 and 6-7 are rejected under 35 U.S.C. § 102(e) as being anticipated by Honda et al. (U.S. Patent No. 6,365,840). Claim 1 has been amended and claim 2 has been cancelled. To the extent that this rejection may still apply to the amended claims, the rejection is respectfully traversed.

The present invention relates to methods for manufacturing electronic devices using two-step bonding processes to avoid air trapping in the adhesive. In the first step a semiconductor chip is temporarily bonded to an adhesive coated on a substrate at a first temperature, followed by permanent bonding at a second temperature that is higher than the first temperature. In addition, in the first temporary bonding step, the pressured is applied to an extent that does not cause the opposing connection terminals to be in contact with each other. (paragraph [0014] in the published application No. 2004/0079464).

Air trappings in the adhesives that bond electronic devices severely degrade the performance of the devices. The inventors have found that air trapping can be reduced by lowering viscosity of the adhesive so as to increase the wettability of the adhesive and substrate or chip, and that the viscosities of commonly used adhesives are lower in the temperature range between the (curing) reaction start temperature and the peak reaction temperature (see Figs. 5-7).

The reaction start and peak temperatures for any adhesive can be identified by calorimetry, as shown in Fig. 4.

A method in accordance with embodiments of the invention involves two steps. In the first step, the adhesive is heated to a temperature that is no less than the reaction start temperature of the adhesive. During this temporary bonding process, the adhesive has a significantly *lower viscosity* and *better wettability* with the electronic device and substrate. Therefore, air trapping is less likely to occur. Afterwards, the devices are permanently bonded by heating to a temperature no less than the reaction peak temperature of the adhesive.

Amended independent claim 1 includes the limitation of "a temporary bonding step of pressing the semiconductor chip onto the adhesive in a state wherein the adhesive is heated to *a first temperature no less than a reaction start temperature of the adhesive* and below a reaction peak temperature of the adhesive."

In contrast, Honda et al. discloses a method capable of achieving electrical connection via conductive particles regardless of a slight unevenness of an object material. (Col. 4, ll. 6-8). In accordance with Honda's method, a film-like adhesive layer is disposed on the first object, and a paste is disposed on the film-like adhesive layer. The paste preferably has a lower viscosity so it can flow. When the second object is placed on the assembly, the paste will move out, but the adhesive layer will remain. Therefore, regardless of a slight unevenness in the first object, the first object and the second object can be closely fit to each other, and the electrical connecting portion of the first object can be electrically connected to the electrical connecting portion of the second object positively by using the conductive particles in the film-like adhesive layer. (Col. 4, ll. 24-41).

Although Honda et al. discloses a two-step process. This two-step process is very different from that recited in claim 1 of the present invention. According to Honda et al., "[a]t the first pressure heating step S5, as shown in FIG. 4(B), the IC 2 is placed on the film-like adhesive layer 6, so that the paste 9 is spread over along the film-like adhesive layer 6. Thus, as shown in FIG. 4(B), the gap between the one surface 2A of the IC 2 and the film-like adhesive layer 6 is almost filled with the paste 9. The reason of this is that because the viscosity of the paste 9 is lower than that of the film-like adhesive layer 6, only the paste 9 is spread around so that the gap between the one surface 2A of the IC 2 and the film-like adhesive layer 6 is filled with the paste 9. In a state shown in FIG. 4(B), the binder 8 and paste 9 are temporarily hardened just. Therefore, a heat to be applied at this time is of a temperature lower than a glass transition temperature of the paste 9 and binder 8, for example, 80 °C for about three seconds. At that time, a pressure of about 3 kg/mm^2 is applied to an area of the protruding electrodes 3 of the IC 2 to be connected to the wiring pattern 5 of the printed wiring board 4 via the conductive particles 7 while they are being heated." (col. 8, ll. 3-20). In the second step, the temperature is above the temperature for glass transition of the paste 9 or binder 8, for example, 180-230 °C. (Col. 8, ll. 23-26).

Honda's two-step method is based on *glass transition temperatures of the paste*, not the *reaction start or peak temperatures of the adhesive*. The glass transition temperatures of the pastes are very different from the reaction start temperatures (e.g., 70-90 °C in Figs. 5-6) or reaction peak temperatures (e.g., 110-120 °C in Figs. 5-6) of the adhesives. Furthermore, Honda et al. does not teach finding a condition to produce *lower viscosity of the adhesive layer* during the first step. Instead, it teaches using temperature and pressure to produce temporary hardening of the paste in the first step.

In view of the above, Honda et al. fails to teach or suggest the limitations of the amended claim 1. Therefore, claim 1 is patentable over Honda et al. Dependent claims 3 and 6-7 should also be patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

(B) Claims 1-3, 6-7, and 10-11 are rejected under 35 U.S.C. §102(e) as being anticipated by Takeshita et al. (U.S. Patent No. 6,458,236). Claim 1 has been amended and claim 2 has been cancelled. To the extent that this rejection may still apply to the amended claims, the rejection is respectfully traversed.

As noted by the Examiner, Takeshita et al. discloses a method that first turns an adhesive layer into a semi-set state. Then, an electric part is placed on the semi-set adhesive layer. Finally, the electric part is heated to a temperature higher than that needed for semi-setting. (Col. 7, ll. 39-59). Again, Takeshita does not teach anything related to reaction start or reaction peak temperatures of the adhesive.

More importantly, the electric part is placed on the adhesive only after the adhesive has been turned into semi-set state. Claim 1 of the present invention requires that "when the semiconductor chip is pressed onto the adhesive in the temporary bonding step." To avoid trapping air between the electric device and the substrate, a method of the invention involves placing the adhesive between the electric device and the substrate before starting the curing process. The start of the curing reaction gives the adhesive lower viscosity and better wettability, which in turn leads to no or little air trapping between the electric device and the substrate. By placing the electric part on the semi-set adhesive, as taught by Takeshita et al., these advantages cannot be realized.

In view of the above, Takeshita et al. does not teach or suggest limitations of the amended claim 1. Therefore, claim 1 is patentable over Takeshita et al. Dependent claims 3, 6-7, and 10-11 should also be patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

Rejection(s) under 35 U.S.C § 103

(A) Claims 4-5 and 8-9 are rejected under 35 U.S.C. § 103(a) as being unpatentable over one of Honda et al. (U.S. Patent No. 6,365,840) or Takeshita et al. (U.S. Patent No. 6,458,236) in view of JP 2-226738 and JP 11-330162. These claims depend from claim 1. Claim 1 has been amended. To the extent that this rejection may still apply to the amended claims, the rejection is respectfully traversed.

The Examiner relies on JP 2-226738 for teaching the use of processing tables and JP 11-330162 for teaching heating from the substrate side. These two references do not teach that which is missing in Honda et al. and Takeshita et al., namely, two-step processes with reference to (curing) reaction start and peak temperatures of the adhesives. Therefore, Honda et al., Takeshita et al., JP 2-226738, and JP 11-330162, whether considered separately or in combination, cannot render claim 1 obvious. Dependent claims 4-5 and 8-9 should also be patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

(B) Claims 12 and 13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over one of Honda et al. (U.S. Patent No. 6,365,840) or Takeshita et al. (U.S. Patent No. 6,458,236) in view of JP 11-330162. These claims depend from claim 1. Claim 1

has been amended. To the extent that this rejection may still apply to the amended claims, the rejection is respectfully traversed.

The Examiner relies on JP 11-330162 for teaching heating from the substrate side. This reference doe not teach that which is missing in Honda et al. and Takeshita et al., namely, two-step processes with reference to (curing) reaction start and peak temperatures of the adhesives. Therefore, Honda et al., Takeshita et al., and JP 11-330162, whether considered separately or in combination, cannot render claim 1 obvious. Dependent claims 12 and 13 should also be patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

(C) Claims 10 and 11 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Takeshita et al. (U.S. Patent No. 6,458,236) in view of Honda et al. (U.S. Patent No. 6,365,840). These claims depend from claim 1. Claim 1 has been amended. To the extent that this rejection may still apply to the amended claims, the rejection is respectfully traversed.

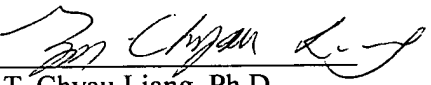
As noted above, neither Honda et al. nor Takeshita et al. teaches or suggests a two-step process with reference to (curing) reaction start and peak temperatures of the adhesive. Therefore, Honda et al. and Takeshita et al., whether considered separately or in combination, cannot render claim 1 obvious. Dependent claims 10 and 11 should also be patentable for at least the same reasons. Accordingly, withdrawal of this rejection is respectfully requested.

Conclusion

Applicant believes this reply is fully responsive to all outstanding issues and places the present application in condition for allowance. If this belief is incorrect, or other issues arise, the Examiner is encouraged to contact the undersigned or his associates at the telephone number listed below. Please apply any charges not covered, or any credits, to Deposit Account 50-0591 (Reference Number 03310/033001).

Dated: February 21, 2006

Respectfully submitted,

By 

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